INVESTIGATOR'S ANNUAL REPORT

United States Department of the Interior

National Park Service

All or some of the information you provide may become available to the public.

OMB # (1024-0236)
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Form No. (10-226)

Reporting Year:	**Park:**	**Select the type of permit this report addresses:**
2009	Shenandoah NP	Scientific Study

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Project Title (maximum 300 characters):

The Next Generation: Deer Browsing on the Growth, Survival, and Demography of Tree Seedlings in the Shenandoah National Park

Park-assigned Study or Activity #:	**Park-assigned Permit #:**	**Permit Start Date:**	**Permit Expiration Date:**
SHEN-00347	SHEN-2009-SCI-0013	Jun 17, 2009	Dec 31, 2009

Scientific Study Starting Date:	**Estimated Scientific Study Ending Date:**
Mar 01, 2008	Dec 31, 2010

For either a Scientific Study or a Science Education Activity, the status is:	**For a Scientific Study that is completed, please check each of the following that applies:**
Continuing	__ A final report has been provided to the park or will be provided to the park within the next two years __ Copies of field notes, data files, photos, or other study records, as agreed, have been provided to the park __ All collected and retained specimens have been cataloged into the NPS catalog system and NPS has processed loan agreements as needed

Activity Type:

Research

Subject/Discipline:

Plant Communities (Vegetation)

Purpose of Scientific Study or Science Education Activity during the reporting year (maximum 4000 characters):

Populations of white-tailed deer have substantially increased in the eastern United States over the last 100 years and are currently at record high levels in some areas. Increased browsing pressure by growing deer populations on tree seedlings can affect seedling growth, survival and ultimately forest succession and the composition of the future forest community. It is important to understand changes in forest succession given that many tree species are becoming locally extinct and may experience further changes due to introduced forest pathogens and changing climate regimes. This study uses four 200 x 200 m deer exclosures, which have been in place for approximately 14 years, to examine the effects deer herbivory on the growth, survival and demography of northern red oak

(Quercus rubra) tree seedlings growing in the forests of the Shenandoah National Park.

Our objectives in this study were to test two hypotheses. First, we expected release from white-tailed deer herbivory would result in the increased survival, but slower growth rate of northern red oak seedlings. Second, given the increased densities of tree seedlings and other herbaceous plants that have resulted from 14 years of white-tailed deer exclusion, we hypothesized that fewer resources would be available to mature trees which would result in decreased growth rates relative to those in areas exposed to deer. Thus white-tailed deer can directly affect the current and future tree communities of forests by directly influencing the survival, growth, and mortality of tree seedlings, but deer also indirectly affect the growth rates of adult trees in a forest community.

Findings and status of Scientific Study or accomplishments of Science Education Activity during the reporting year (maximum 4000 characters):

Our findings support both of our hypotheses. Herbivory by white-tailed deer can have large effects on seedling populations and potentially on the structure and composition of red oak communities and eastern deciduous forests in general. This is important because many different species within the forest ecosystem, including chipmunks, birds, and even soil fungi, depend on acorn crops or other ecological services provided by oak trees. Any effects on oak trees that result in changes in the acorn crop or the other ecological services they provide may have repercussions on the other species that depend on oak trees.

Specifically, we found densities of northern red oak seedlings were significantly greater inside deer exclosures than outside exclosures which were exposed to ambient levels of deer browsing. Survival of northern red oak seedlings were 24% higher inside deer exclosures than outside exclosures. Likewise, seedling heights were significantly greater inside the exclosures. The growth rate of seedlings tended to be slower inside the exlcosures, but this difference was not statistically significant. We measured acorn production inside and outside the exclosures, but there were no significant differences when acorn production is standardized per m2 of trunk basal area. Our data suggest growth rates of adult trees (i.e. trees with a diameter at breast height > 10 cm) may be influenced by white-tailed deer herbivory. Growth rates of adult trees in a control area outside one of the enclosures was greater than the growth rates inside of the exclosure, as might be expected if there were greater competition for resources inside the enclosures due to greater tree seedlings densities. Importantly, growth rates of adult trees in control areas outside three other enclosures were less than growth rates inside of the exclosures. This suggests an important interaction exists between growth rates of adult trees and sites. This may be caused by differences in the deer population at the four sites, differing nutrient availability at the sites, or some other unstudied biotic or abiotic factor.

Conclusion: White-tailed deer herbivory affects the growth and survival of northern red oak seedlings and may also affect the growth rate of adult trees. Such impacts by white-tailed deer will ultimately influence the composition, structure, and dynamics of the current population of northern red oak trees and forest ecosystems in the future.

Update for 2009: We completed sampling of the red oaks in a fourth deer exclosure and its control area, helping to verify the trend of increased growth rates of adult trees inside the deer exclosures.

For Scientific Studies (not Science Education Activities), were any specimens collected and removed from the park but not destroyed during analysis?

Yes

If "Yes", identify where the specimens currently are stored:

Tree core samples are currently stored in my lab at the University of Wyoming. They will be returned to the park upon completion of the project.

Funding specifically used in this park this reporting year that was provided by NPS (enter dollar amount):	**Funding specifically used in this park this reporting year that was provided by all other sources (enter dollar amount):**
$0	$1500

List any other U.S. Government Agencies supporting this study or activity and the funding each provided this reporting year:

Paperwork Reduction Act Statement: A federal agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. Public reporting for this collection of information is estimated to average 1.625 hours per response, including the time for reviewing instructions, gathering and maintaining data, and completing and reviewing the forms. Direct comments regarding this burden estimate or any aspect of this form to Dr. John G. Dennis, Natural Resources (3127 MIB), National Park Service, 1849 C Street, N.W., Washington, DC 20240.